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## (54) CAMOUFLAGE SHEET WITH HOLE PATTERNING

(71) We, BARRACUDAVERKEN AB, a Swedish Body Corporate, of Skärsnäsvägen 4, S-182 63 Djursholm, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a pliable, flexible or stiff camouflage sheet in which hole patterning at least partly produces the camouflaging effect.

The designation "camouflage sheet" as employed below for the subject of the invention comprises any fabric and/or plastic foil with or without a supporting net, a tarpaulin, a pliable or completely stiff sheet or plate, which is provided with a visual camouflage effect.

As is well known, it was and still is quite common that camouflage sheets are made as nets with applied plastic or fabric pieces, so-called appliqué garniture, and thus do not form a closed surface. It is also known to furnish a sheet with normally irregular apertures to increase the camouflaging effect, but primarily to make it possible to look through the camouflage sheet without being seen. In addition it is desirable that precipitation does not form pools, rivulets, ice-coatings or shiny surfaces as a result of the camouflage acting as a closed roof. A sheet having numerous apertures is, in addition, less likely to flutter from wind or foam pressure waves eminating from projectile explosions or projectile firings.

For each type of camouflage sheet there is a certain range within which the camouflage is ineffective, i.e. the eye can register the camouflage details without their merging with the surrounding. This close-up range should be small and is dependent on several factors, but it does happen that a camouflage is chosen where this range is relatively large, but where the camouflage effect is even better at considerably greater range. Camouflage can also have another function, namely rendering aiming difficult in the shooting of a camouflaged target.

An otherwise effective camouflage encounters considerable difficulties in smooth terrain such as meadows, desert, steppe, snow-covered fields and frozen or unfrozen lakes and streams. In such cases one generally uses unpatterned or slightly patterned camouflage having the same colour as the surroundings, but the camouflage sheet seldom has the exact same colour and essentially always forms folds and surface sections which—according to the lighting—produce shadows or varying degrees of brightness which contrast with the surroundings to a certain extent. This can be alleviated by using a camouflage sheet having apertures, e.g. a sheet consisting of a camouflage net with appliquéd garniture, whereby even the background of the sheet becomes visible to a certain degree through the apertures in the sheet, which is often a known advantage. Such sheets, however, have disadvantages precisely in said "monotonous" surroundings are more expensive and the garniture can relatively easily be torn away during transport and dragging along the ground unless it is attached in a special way which further increases the cost.

In accordance with the invention in a camouflage sheet in which a visual camouflage effect is at least partly produced by holes punched in the sheet; each hole being circular or substantially oval, having a smoothly curved periphery and being positioned at a point of intersection of a substantially equiangularly triangular grid array, the arrangement is such that the density of holes is different in different areas of the sheet and the linear dimensions of which areas are large by comparison with the separation of adjacent points of the grid array. The sheet is thus furnished with numerous punched apertures, so distributed that a camouflage pattern is formed by these apertures, and it is possible to avoid the previous mentioned disadvantages to a degree, in addition to which the sheet may be relatively light and nearly as durable as a closed coherent sheet, i.e. a sheet without apertures. This also has a certain significance in that it is possible to avoid a supporting net for the actual sheet, or to use a supporting net

which is both lighter and less expensive than a net for appliquéd garniture. Providing a sheet with apertures of varying dimensions and varying distribution encounters purely practical difficulties, however, if the sheet is not to be too expensive and, additionally, is not to display a pattern repeat which is too small. As is well known, pattern repeat is related to the distance at which a given pattern is repeated on the sheet, since machine pattern printing, appliquéing, hole punching, etc. is usually carried out with tools (printing plates of the like) of limited size. This can, indeed, be avoided with successively operating tools which are controlled by paper tapes, computers or the like, but production thereby becomes expensive and complicated, i.e. because it is not only pattern repeats which are too small which are to be avoided, but also pattern sections which are unsuitable for the intended camouflage effect.

It is simplest to produce camouflage sheets having a camouflage pattern formed entirely or in part by apertures, using a plate or rotatable cylinder fitted with hole punches. Hole punching of an entire pattern section on the sheet is effected in a way similar to printing, in that said plate (or cylinder) punches holes instead of printing. It should, however, be possible to shift the individual hole punches on the plate so that the plate can be used for different patterns. This implies that the plate must be furnished with mountings for removable hole punches at all places, i.e. at so-called positions, where hole punches are to be attached. The mountings thus form a grid array on the plate. Alternatively the mountings can form one or a small number of arrays on a type of bar whereby the pattern section is hole punched row by row and whereby certain hole punches are made operative or inoperative under the control of a program by per se known mechanical, pneumatic or electrical means each time (or nearly each time) a new row of holes is punched, so that the distribution of the holes changes during the punching of the entire pattern section. In this case the hole punches must be program controlled, which means that the punched holes will be located at points of an imaginary grid array. In hole punching by means of the plate it is likewise obvious to arrage each hole punch mounting in its own intersection in the grid. For reasons previously mentioned the possibility of distributing the holes entirely irregularly and other than in accordance with the invention is here ignored.

The holes should be circular or substantially oval, i.e. possibly elliptical, and should not show indications of tearing, i.e. should have a continuous smoothly curved periphery without sharp edges or other discontinuities. Furthermore, the holes should be neither too large nor too small, both with respect to the desired camouflage effect at the range and for the target in question and to practical demands.

In connection with the work leading up to the invention it was recognized that a rectangular grid array, i.e. a grid array on the Cartesian co-ordinate system with square or at least rectangular grid arrays, resulted in a relatively large close-up range or "sight range", i.e. the minimum range at which the hole groups are only just perceived as being artificial. The polar co-ordinate system is of little value for various reasons, i.e. from the standpoint of camouflage and manufacturing.

By making the sheet in accordance with the invention, on the other hand, it is possible to significantly reduce said sight range and to also obtain a somewhat greater freedom of choice in the placement of the holes and somewhat greater sheet durability compared to a sheet whose holes are placed according to a rectangular co-ordinate system or grid array.

Figure 1 shows examples of grid arrays for holes in a camouflage sheet according to the invention, and

Figure 2 shows an example of a hole pattern section in simplified form in that, in reality, the grid array for a pattern according to Figure 2 must be significantly finer and the number of holes greater than that which is shown.

Figure 1 shows a grid array according to a per se known two-dimensional co-ordinate system having three co-ordinate axes which form 60° angles with one another. This system is called "triangular". The thusly obtained grid according to Figure 1 therefore consists of numerous equilateral triangles, but can also consist of regular hexagons arranged as in a honeycomb. The equilateral triangles or hexagons need not be equally large within the entire pattern section, i.e. the field which with pattern repeat may be repeated on the sheet. At the top of Figure 1 is shown a triangular grid array having larger triangles than these at the bottom of Figure 1.

Mountings for hole punches are arranged on a hole punch plate at those points which coincide with the vertices of the triangles according to Figure 1. This does not necessarily mean that the mounting must be located at all such vertices, and the mountings need not coincide exactly with the vertices. The discrepancies should not, however, be so large that a significant number of triangles are right-angled triangles or otherwise deviate markedly from the form of a substantially equilateral triangle. The equivalent applies to rotary punching with a hole punch cylinder, and also to the program control in the above-mentioned method of punching row by row (or column by column).

The holes may be of various sizes, that is various diameters for circular holes. A plurality of the holes may be circular with a first common diameter and at least another plurality of the remaining holes may have a common second diameter which is at least 25% and at most 100% larger than the first-mentioned diameter. Figure 2 shows an example of a hole pattern section having two different hole sizes, but having a single common triangular grid array which Figure 1 shows two such grid arrays joining one another within the entire sheet or within a sheet section. The two arrows 1 indicate separate regions within which small holes have the densest possible distribution, namely so that every vertex in the triangular grid array is occupied by a hole, as indicated by the broken lines below the tip of the left-hand arrow 1. The arrow 2 indicates a region with small holes in sparser distribution so that the holes coincide with the vertices of hexagons which together form an equiangularly triangular grid array resembling a honeycomb. The arrows 3 indicate separate regions having larger holes in the densest possible distribution in the same way as the small holes in the regions indicated by the arrows 1. The arrow 4 indicates a region having large holes in a distribution sparser than the densest possible.

According to the fineness (vertex spacing) of the grid array and to requirements pertaining to the camouflage in question, it is also possible to choose a single hole size or to use more than two hole sizes, but preferably not more than three.

It is easily seen that the specific hole density, i.e. the ratio between the combined surface area of the holes within a given region and the total area of this region, may be chosen within very broad limits. The lower limit is, of course, zero, i.e. no holes in the region, while the upper limit depends primarily on the demands on the durability and on the construction of the sheet, e.g. whether it is furnished with a supporting net or not. Taking region 3 as an example, it can be seen that adjacent vertical hole groups (columns) are offset by one-half the distance between hole centres. In a corresponding rectangular (Cartesian) grid array a similar offset would not result in equilateral triangles, which means that for the same number of holes per unit area the minimum distance between two adjacent holes is markedly smaller than in the equiangularly triangular grid array according to Figs. 1 and 2, and that the sheet durability is considerably greater with the equiangularly triangular grid array than with a rectangular grid array (and even significantly greater still than for a polar coordinate grid array).

A camouflage sheet according to the invention may easily be furnished with a normally imprinted camouflage pattern, and may be executed for infra-red camouflage and for radar camouflage. For radar camouflaging according to British Patent Specification No. 1 314 624 it must be observed that the requirements for radar camouflaging disclosed therein must be met by the hole-punched sheet, but not by the sheet prior to punching, and that the indicated coefficient of reflectivity of at least 10% should be at least 25—40%. According to the composition, design, hole size and hole distribution of the sheet, the hole edges and/or interspaces between the holes can entail certain high frequency effects and therefore a finished sheet (preferably a prototype) according to the present invention intended for radar camouflaging according to the above-mentioned patent should be tested by means of practical tests of its radar camouflaging effect, particularly with respect to background reflections in the camouflaging of vehicles, artillery, etc.

The invention can also be used for a camouflage sheet with drastic camouflaging and/or camouflage patterns composed of square or rectangular pattern sections of relatively appreciable size and, possibly, of varying degrees of brightness, that is varying specific hole density for different sections. Favorable results have been attained using two hole diameters of 32 and 42 mm on one and the same sheet for winter camouflage. In certain other cases two sizes of 25 and 40 or 45 mm have proved to be appropriate. For camouflaging very large objects larger hole sizes may be appropriate. In simpler cases, e.g. camouflage sheets for individual persons, a single hole size has proved to be sufficient.

The camouflage sheet is preferably made from plastic film, optionally fabric such as plastic-impregnated fabric, whereby the film or fabric can be glued or welded to a supporting net. If the sheet is furnished with a supporting net it is normally of no significance for the camouflage effect if the net threads extend over the holes or a portion of the holes, even if the net is a different colour from the sheet surface. It is thus simple to attach the net since the holes can be disregarded. In the event one wishes to attain the greatest possible strength using the weakest possible net, i.e. to increase the pliability of the sheet, it is, however, feasible to join the net to the film or fabric in such a way that the net threads everywhere extend between the holes and thus not across the holes. This can be accomplished by choosing a net, if it is assumed to be a common net having rectangular meshes, with a net size, i.e. a rectangular coordinate grid array, that it can be adapted to the equiangularly triangular hole array, or vice-versa. Alternatively, the net can be

made in accordance with the equiangularly triangular grid array with triangular meshes whose side length is preferably a multiple of, i.e. at least twice as large as, the side length of the triangle of the grid array, whereupon the net is fitted to the foil or fabric in a suitable way upon attachment. A net made in this way is per se more expensive than a normal net, but on the other hand it is per se stronger and, in addition, provides considerably increased support to the sheet and can therefore be made with relatively thin net threads and has low weight.

It is also possible to reinforce the hole-formed foil or fabric of the sheet by attaching parallel threads thereto which extend in a single direction, approximately like the strings of a harp.

A camouflage sheet according to the invention can be made with different colours on its two sides in a particularly simple manner so that, for example, one side is white for winter camouflage and the other side is colour-patterned or sand yellow for camouflaging in normal terrain and in sand regions, respectively.

Existing camouflage sheets with closed surfaces whose camouflage pattern is for some reason no longer usable, e.g. because of sharp discoloration or bleaching, can be made usable again by means of hole punching forming a sheet according to the invention.

An important possible use for the invention is that a common camouflage sheet having per se known camouflage patterns, but particularly an essentially single-coloured camouflage sheet for use in snow, fields, pastures, desert or the like is furnished with holes at one or more edge portions, normally on all edges, so that hole-punched sheet regions of preferably irregular form are obtained; starting from the edges of the sheet, the hole density becomes more and more sparse towards the centre. At least the majority of the holes nearest the edge or edges of the sheet may or should have greater diameter than the majority of the holes further from the edge.

By furnishing a common camouflage with such hole regions around its edges, a contrast-leveling and mechanically smoother transition to the surrounding terrain may be attained so that any contrast between the camouflage colour or pattern and the colour or pattern of the surroundings is lessed or blurred. In addition, said step provides convenient sight holes and allows that the edge portions of the sheet can more easily be fastened with ropes, straps, hooks or the like, since these can be threaded through the holes. It may therefore be an advantage if a number of holes near the edge of the sheet are furnished with a known hole reinforcement of plastic or metal. Within a given region from the edge of the sheet the size and distribution density of the holes may very well be so large that a considerable portion of the background behind the sheet, i.e. normally the terrain under the edge portions of the sheet. is visible through the holes so that a somewhat uniform transition between the ground appearance and the sheet appearance is obtained. In this way any contrast, normally already negligible, is reduced.

At least in normal cases the distribution density and size of the holes should vary, not only in the direction from the edge of the sheet towards the centre, but also along the edge and edge portions of the sheet, e.g. according to Fig. 2. Thus, if a rectangular camouflage sheet is assumed to lie directly on the ground, its edges should not be accentuated by having a row of equally large holes with equal distribution extending parallel to the edges. Uneven hole size and/or uneven distribution (density) of the holes should therefore be sought, even in the circumferential direction of the sheet. For this reason i.e. extra holes can be arranged which are not incorporated into the triangle grid array of the remaining holes and which, in addition, can serve in the securing of the sheet.

WHAT WE CLAIM IS:—

1. A camouflage sheet in which a visual camouflage effect is at least partly produced by holes punched in the sheet; each hole being circular or substantially oval, having a smoothly curved periphery and being positioned at a point of intersection of a substantially equiangularly triangular grid array, the arrangement being such that the density of holes is different in different areas of the sheet and the linear dimensions of which areas are large by comparison with the separation of adjacent points of the grid array.

2. A sheet according to claim 1, characterised in that a plurality of the holes are circular with a first common diameter and that at least another plurality of the remaining holes have a common second diameter which is at least 25% and at most 100% larger than the first-mentioned diameter.

3. A sheet according to any one of the preceding claims, characterised in that the holes are positioned at points of intersection of at least two equiangularly triangular grid arrays of different size and situated in separate regions of the sheet.

4. A sheet according to any one of the preceding claims, characterised in that at least one side of the sheet is white for winter camouflage.

5. A sheet according to any one of the preceding claims, characterised by a supporting net with a foil or fabric attached thereto and which has been furnished in advance with hole patterning so that the net threads extend uninterruptedly over the

sheet, independently of its holes, which may thus be traversed by the threads.

6. A sheet according to any one of claims 1 to 4, characterized by a supporting net with a foil or fabric attached thereto and the holes of which are so placed that they coincide with net meshes, so that the holes are not traversed by net threads, the mesh size being at least twice as large as the side length of the triangles of the grid array.

7. A sheet according to any one of the preceding claims, characterized in that a layer of electrically conductive material for radar camouflage is incorporated in the sheet in such a way that the finished hole-patterned sheet meets the requirements of at least claim 1 of British Patent No. 1 314 624 with radar reflection higher than 25%.

8. A sheet according to any one of the preceding claims, characterized in that the hole patterning extends substantially only over the edge portions of the sheet and not over the entire sheet which, in addition to hole patterning, also has another camouflage or colour.

9. A sheet according to claim 8, characterized in that in the edge portions the ratio between the total area of all of the holes and the total area remaining between the holes diminishes from the edge of the sheet towards the centre of the sheet.

10. A sheet according to claim 9, characterized in that the ratio varies non-uniformly in a direction parallel to the edges of the sheet.

11. A sheet according to claim 9 and 10 together, characterized in that sheet regions within which the ratio is constant have irregular form, and in that at least a portion of such regions have a form different from that of the other regions.

12. A camouflage sheet with hole patterning substantially as hereinbefore described with reference to the accompanying drawings.

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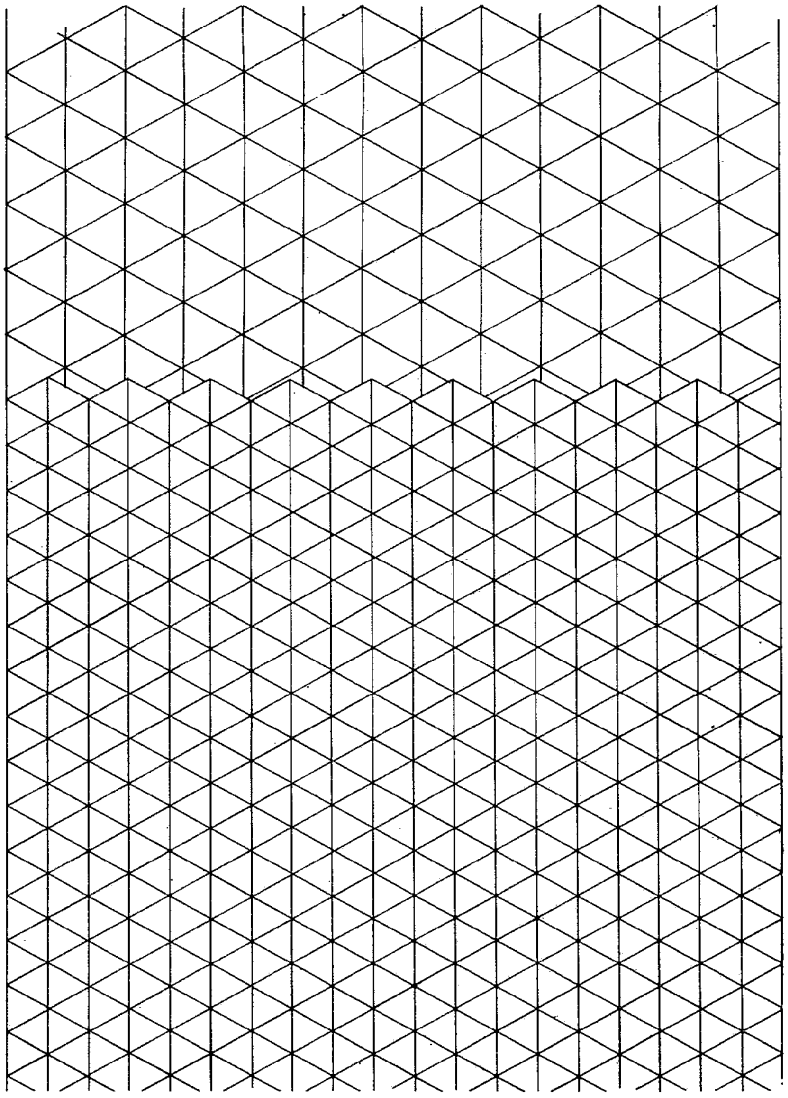
1 535 260 COMPLETE SPECIFICATION
2 SHEETS



FIG. 1



1 535 260
2 SHEETS

COMPLETE SPECIFICATION



SHEET 2

FIG. 2